Report for 2005SC15B: Environmental Predictors of Mercury Methylation Potential and Fish Tissue

Publications

- Unclassified:
  - Pac, C.R., A.J. Jones & E.R. Carraway. 2005. Metal Toxicity to Ceriodaphnia dubia as a Probe of the Kinetic Lability of Metal Complexes. Society of Environmental Toxicology and Chemistry (SETAC) North America 26 Annual Meeting, Baltimore, MD (November 13-17, 2005).
  - Jones, A.J., C.R. Pac & E.R. Carraway. 2005. Alkalinity Effects on Metal Speciation and Toxicity to Ceriodaphnia dubia in Waters of Varying Hardness. Society of Environmental Toxicology and Chemistry (SETAC) North America 26th Annual Meeting, Baltimore, MD (November 13-17, 2005).

Report Follows

Project title:

Environmental Predictors of Mercury Methylation Potential and Fish Tissue Concentrations in a Blackwater River

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Executive Summary:

Mercury (or Hg) contamination in freshwater fish has emerged as an important environmental issue at a national scale, with fish consumption advisories in 43 states by the end of 2004, an increase over 2001 and 2002 (US EPA). This project proposed to investigate biotic and abiotic factors affecting mercury contamination of fish in water characteristic of the "blackwater" rivers in South Carolina (generally low pH and dissolved oxygen levels and high concentrations of carbon, primarily humic and fulvic acids) through collection and analysis of existing data and through experimental studies.

Data on fish sampling and contamination levels obtained from the South Carolina Department of Health and Environmental Control (SC DHEC) was mapped and analyzed. Some of the additional characteristics to be included in the study (e.g., the National Atmospheric Deposition Program's (NADP) data for mercury and acid deposition, locations of coal-fired power plants and municipalities, toxic release inventories, prevailing wind and weather patterns, and drainage characteristics) were either unable to be obtained or were very limited (i.e., NADP data). The SC DHEC data was parsed for fish types sampled most commonly in order to analyze spatial trends within the Edisto River. Initial results indicate that within the fish data the sample sizes are too small to permit reliable analysis. Additional analyses will continue as PI and student time allow using a broader range of analysis tools such as quantile regression and classification and regression trees (CART). During the project period, Dr. Johnson was in Minnesota and unable to guide the student in more advanced analysis methods.

In the experimental phase of this project, sampling of the Edisto River according to the proposed timeline became problematic because of unusual weather patterns (high rainfall) and the resulting hydrologic conditions. Our plan to coordinate sampling with USGS personnel in Columbia was abandoned because of hydrologic requirements and their need to sample upon short notice depending on hydrologic conditions. Rather we began our study with samples obtained from another blackwater stream, the Ogeechee River in northeast Georgia. We focused on assessing Hg bioavailability via its toxicity to a zooplankton specie characteristic of freshwater food webs, *Ceriodaphnia dubia*, in the presence of Ogeechee River NOM-containing water. This organism has been used extensively in the study of other water contaminants such as copper and the effects of NOM complexation. Simultaneously, method development and verification proceeded for quantification of inorganic and organic Hg forms. Results from the mercury toxicity tests using Ogeechee River NOM show that toxicity is surprisingly independent of NOM concentration. One hypothesis that may explain this result is that at the low levels of Hg required to cause mortality to *C. dubia*, its predominant chemical form is a kinetically labile complex between the "soft" metal and the abundant "hard" oxygen-containing ligands on NOM. Such a labile complex would allow *C. dubia* (and other organisms) to displace NOM-bound Hg. While MINTEQ calculations and fluorescence quenching measurements indicate extensive binding of Hg to NOM, Hg toxicity is only reduced by a factor of three. The kinetic lability of Hg with model ligands and NOM is undergoing quantification (using a fluorescence quenching method) to test this hypothesis. Results show that a sulfur-containing ligand (cysteine) is significantly less kinetically labile than ligands containing oxygen and nitrogen (EDTA and NTA). Results with NOM are difficult to interpret and that is currently under further study. Corresponding studies using a Suwanee River NOM isolate have also been completed and are being analyzed. In Hg analyses, we have achieved sub-ppb levels of detection and quantification for inorganic or Hg^{2+}. Relatively low recoveries initially hampered quantification of organic forms of Hg, but method modifications adopted recently have resulted in satisfactory results.